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# *PARTICLE SOOT ABSORPTION PHOTOMETER (PSAP) NOISE AND AVERAGING*

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**ABSTRACT**

The Particle/Soot Absorption Photometer (PSAP), as manufactured by Radiance Research (Shoreline, WA), provides a measure of particle absorbance based on the changing optical transmittance of a filter as particles are continuously deposited. The time differential of the resulting transmittance signal is related through Beer's law to provide a time series of optical absorption coefficient. Relative simplicity, low cost, and small footprint have led to wide deployment of these units in both ground- and aircraft-based sampling systems. Limitations of the digital optical absorption coefficient signal as produced by the instrument firmware include: roundoff, internal truncation and a summation time set during operation. Another artifact of the instrument firmware is a high autocorrelation in the output. This results in data which is not well-suited to normal boxcar averaging. The noise in this signal does not have the normally expected square root of averaging time dependence. The instrument output also includes raw intensity values which can be externally processed with different summation (averaging) times and without the other firmware shortcomings.

The limitations of the absorption coefficient signal are illustrated. Some of these limitations can be circumvented by externally processing the raw intensity data. Examples of simulated data processing, laboratory tests to measure instrument noise and the application of different averaging methods to aircraft-based measurement data are shown. Guidelines for achieving optimum signal-to-noise as a function of averaging time are suggested. Because the measurement is based on a time differential of the intensity, the noise in absorption coefficient is shown to decrease with the averaging time to the -1.5 power in theory. Experimentally, the exponent was -1.3, but still much different from the -0.5 associated with methods that directly measure absorption coefficient (Photoacoustic Spectroscopy or Photothermal Interferometry).